



EFFECTIVENESS OF VISUAL INFORMATION IN THE PROCESS OF TEACHING SWIMMING MOTOR ACTIVITIES

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ABSTRACT

Purpose. In the process of learning motor functions, it is important to avoid perpetuating the wrong movements. For this purpose, it is recommended to use a combination of various media: speech, demonstration and practical activity. However, in some cases the learning process can be disrupted by difficult conditions (e.g. buzz at a swimming pool), which cause significant disturbance in perception of verbal information. In this situation, the teacher may use visual communication (in the form of gestures). The aim of this study was to determine differences in the accuracy of learning swimming skills (in the experimental and control groups) after implementing visual information (in the form of gestures) in the experimental group. **Basic procedures.** The test method used was a pedagogical experiment conducted among 86 people (40 in the experimental group and 46 in the control group). The difference between the groups consisted in different ways of correcting errors in movements: in the experimental group, I introduced an independent variable – visual information communicated by gestures, while in the control group errors were eliminated by means of verbal information. **Main findings.** Analysis of the results shows that the difference in the coefficients of swimming accuracy in the experimental and control groups is statistically significant and in favour of the experimental group. The result was significantly influenced by the precision of hip joint movements – bending and straightening – reached in the experimental group. Slightly less, but also important were differences in the precision of single movements like arm flexion, dorsal flexion in the talocrural joint and extension of the knee. **Conclusions.** 1. Visual information transmitted using “language of gestures” affects the accuracy of learning swimming motor activities. 2. In teaching of swimming motor activities, visual information is more effective than the information communicated verbally.

Key words: feedback, visual information, gesture, education of swimming

Introduction

Researchers have been interested in the problem of learning for a long time. Some of them have dealt with the issue of mental learning, others with that of motor learning.

In new theories the difference between skill learning and mental learning is hardly visible. After having studied the process of acquiring motor skills, scientists state that it is very complex, as it involves creating both motor plans and programmes based on a thorough analysis, thinking, and cognitive processes [1].

Psychologists treat the terms “learning” and “memory” as equivalent, though memory is regarded as the organism’s ability to store the acquired experiences, whereas learning as a manifestation of this storing expressed in behaviour. A learning process starts from memorizing incoming information in the short-term memory (STM). However, its capacity is limited (~7 units), and duration is very short (15–30 seconds); in addition, it cannot be reconstructed, so the information encoded at this level is quickly forgotten. To remember it for a longer period of time, it must reach the long-term memory (LTM), which is a permanent memory store.

For physiologists, learning consists in increasing effectiveness of synapses and in reducing physiological cost needed to do an action. Therefore, it depends on plastic properties of the nervous system, which is involved in developing any changes in behaviour [2]. Every process of acquirement has its origin in retention of the incoming information at the fresh memory level. This level comprises the sensory memory, which is responsible for keeping a trace of a stimulus action in the analyzer, and the short-term memory, which lasts as long as there are nervous impulses circulating between sensory fields and associating ones of the cerebral cortex.

To store new contents in LTM, a neuron receiving information must reach a certain stimulation level. Multiple repetition of the same stimuli contributes to changes in sensibility of the neuron’s cell wall, which starts reacting to less quantity of neurotransmitter than before. This change, which is defined as a long-term synaptic reinforcement, reinforces considerably the synapses between the neurons sending and those receiving information [3–6].

The greatest influence on permanent retention of information has repetition, which enables the learned contents to be used more easily in the future. However,

during repetition, also some undesired information can reach the permanent memory; for example, errors occurring while learning motor activities. Errors repeated many times result in permanent retention in LTM. But not all imperfections need immediate correction [7, 8]. Defects, i.e. deflections, which result from individual differences between exercise doers, are normal and do not require a pedagogical intervention. They can be treated as superimposition of a technique on the student's individual characteristics. The teacher's intervention, in such a situation, consists in modification of the pattern and adjustment of the requirements to the learner's capacities.

In addition, an immediate correction is not required in the case of inadequacies, i.e. defects of certain movements whose images the learner has already in mind. Correction of inadequacies is limited to providing the learner with information (verbal, visual, sensory) about the occurrence of inadequacies, because the learner usually is not aware of his/her shortcomings. While learning, it may also turn out that an activity deviates from an intended goal, because some movements at variance with an anticipated activity plan (errors) occurred. Errors must be eliminated as soon as possible, because they hinder effectively a correct acquirement of a new activity. In order to prevent from perpetuating undesirable movements in the permanent memory, it is necessary to spare no effort so that the acquiring activity is executed properly. That is why, while performing an activity, the student should be constantly provided with detailed information about the movement structure and how to correct occurring errors [8].

The teacher, giving the learner information about a movement structure, can make use of different media: verbal information, i.e. speech, visual information, i.e. demonstration, and kinetic information, i.e. acting in practice [8–11].

In order to acquire properly a new activity, it is necessary to make use of all the information media at the same time. It means that verbal communication should be reinforced by a demonstration and complemented with sensory impressions; the lack of one of them may cause disturbances in effectiveness of the entire learning process [1].

In some situations learning is disrupted by difficult conditions (for example, buzz at the swimming pool during swimming lessons) which cause significant disturbances in receiving verbal information. As a result, the student cannot hear messages how to execute a movement and that it is possible to correct it, which contributes to the incorrect activity execution [7, 8]. In this situation, in order to compensate insufficiency of

verbal information (words), the teacher should make use of non-verbal information media, for example, visual information. Visual information can have a form of symbols, i.e. signs or gestures. Such an elementary sign in a process of transmitting information about human movements is a sensorimotor sequence [12]. Using the notion of a sequence, it is possible to distinguish the most important elements of a movement in an activity being taught and then, in a simplified way, change them into visual signs (gestures), and only in such a form communicate students indispensable information about the movement structure.

In order to make the communication through gestures (signs) possible, there must be a common repertoire, where signs mean the same both for the teacher and the learner. The point is that learners should recognise unequivocally the gestures made by the teacher and that their interpretation should be in accordance with the teacher's intention [9, 11]. Due to the information communicated in this way the learner can systematically verify his/her idea about the movement and correct the wrong movements in order to get closer to a previously intended goal. In learning, as Kotarbiński [13] claims, the most important is effectiveness. In the case of learning an activity, one can speak about an effective activity only when it leads to a previously intended goal. The achieved goal should be as close as possible to the pattern or possibly the least different from the pattern. The more the performance is close to the pattern, the more precisely the activity was performed.

The aim of the work was to establish differences in the accuracy of learning swimming motor activities (in the experimental and control groups) as a result of the application of visual information (in the form of gesture) in the experimental group.

Hypothesis

Visual information communicated by means of a "gesture language" has an influence on the accuracy of learning swimming motor activities.

Material and methods

Selection of learners for the experiment

74 pupils, aged 9 years, from Primary School No. 5 in Opole and 62 pupils, aged 9 years, from Primary School No. 12 in Kędzierzyn-Koźle took part in the experiment. In both schools there were similar teaching and school conditions.

The selected pupils participated in an obligatory swimming course, which consisted of eight 45-minute lessons held once a week. Since motor, somatic and intellectual differences between boys and girls at this age do not have significant importance in teaching physical education, the experiment was held in coeducational groups [14, 15].

The basic qualification criterion to take part in the experiment was the lack of ability to swim. However, before the experiment started all the subjects had undergone a preliminary adaptation to the water environment, which lasted four consecutive lessons. Its aim was to even out the starting level of all the participants. I recognized that children were accustomed to the water if they were able to do the following exercises: to jump to the water no matter in what way, to immerse the head under the water and exhale at the same time, to push themselves with both legs from the swimming pool wall in order to slide on the breast and on the back.

Out of 136 pupils who underwent the preliminary adaptation, 122 were qualified to take part in the experiment; they at most were able to remain afloat. Unfortunately, after having carried out the experiment, I could make a final diagnosis only on 86 persons' performances (40 in the experimental group and 46 in the control group), because the results of the other subjects could not be taken into consideration due to periodical absences from the lessons.

Selection of teachers to the research

Physical education teachers of different seniority (7, 11, 18, 26, 31 years of experience) participated in the experiment. They had a master degree (*magister*) in physical education and were qualified swimming instructors. Each of them conducted lessons in both groups and none of them was told about the main objective of the experiment.

The basic research method was a natural pedagogical experiment. The method of pedagogical experiment consisted in dividing the subjects into experimental and control groups. Swimming lessons were conducted by the same teachers. 45-minute lessons were held once a week for 7 consecutive weeks, during the 8th lesson a test of ability to do the backstroke using the standard technique was held. Lesson subjects and objectives were the same in both experimental and control groups.

For the experiment I chose an ability to do the backstroke, because it is characterised by natural (side-alternating) movements of lower and upper limbs, facilitated breathing (no difficulties to overcome) and a facilitated

pupil's contact with the teacher. In addition, the body lying on the back enables both parts, the teacher and the learner, visual communication (possibility of using gestures) and allows learners to correct occurring errors on their own.

The difference between the experimental group and the control one consisted in the fact that in the experimental group I introduced an independent variable, that is visual information communicated by a gesture whenever there was an incorrect movement. Correction regarded the errors, i.e. elements of movements, which should not appear during the executed movement.

The preparation procedure of the independent variable for the experimental group

In order to communicate by means of gestures, before starting the experiment, I established with pupils the common repertoire of gestures (code). In this way, different gestures were invented, some to correct a wrong position of the body in water, others to correct wrong movements of lower limbs and some others to correct errors in movements of upper limbs [16].

Additionally, before each lesson I reminded the participants the meaning of the gestures which could be used during the lesson and I instructed them to watch carefully my behaviour during the whole lesson and correct their swimming techniques adequately.

In the control group wrong movements were corrected verbally.

The procedure of the accuracy assessment of teaching the backstroke standard technique

After having completed the experiment all the pupils were filmed. The material obtained in this way was used to compare the subjects' swimming techniques with the model technique. To work out a model technique required dividing the taught motor activity into sensorimotor sequences [12]. For this purpose a complete swimmer's cycle of movements while doing the backstroke was filmed. The material recorded on the video tape was processed into digital information (I changed images into numbers) following the procedure adopted by Zatoń [9] in her research. Since movements in all the joints are performed at the same time, I regarded as an earlier movement the one in the joint placed closer to the head (so, first was the movement in the humeral joint, then in the hip, knee joints and finally in the talocrural joint) and the movement of the left side (a movement in a left joint came before a movement in the respective right joint). Such a procedure

Table 1. The significance of the differences between the control and experimental groups in the *U* Mann-Whitney's test

Variable	Rank sum	Rank sum	Value Z corrected	Level p probability	No. of subjects		Exact significance
	E	C			E	C	
Coefficient of swimming accuracy	1998.500	1742.500	2.24	0.0251	40	46	0.0247
Left humeral joint– abduction	1725.000	2016.000	–0.13	0.8963	40	46	0.9006
Right humeral joint– adduction	1740.500	2000.500	0.00	0.9961	40	46	0.9966
Left hip joint – extension	1761.500	1979.500	0.19	0.8499	40	46	0.8531
Right hip joint– flexion	1859.000	1882.000	1.04	0.2966	40	46	0.3066
Left knee joint – flexion	1651.000	2090.000	–0.84	0.4017	40	46	0.4455
Right knee joint – extension	1603.000	2138.000	–1.28	0.2017	40	46	0.2386
Left talocrural joint – sole flexion	1796.000	1945.000	0.66	0.5076	40	46	0.6325
Right talocrural joint – dorsal flexion	1876.000	1865.000	1.64	0.1013	40	46	0.2421
Left hip joint – flexion	2109.500	1631.500	3.23	0.0012	40	46	0.0012
Right hip joint – extension	2139.000	1602.000	3.50	0.0005	40	46	0.0004
Left knee joint – extension	1841.000	1900.000	0.97	0.3322	40	46	0.3861
Right hip joint – flexion	1842.500	1898.500	1.00	0.3181	40	46	0.3767
Left talocrura joint – dorsal flexion	1956.000	1785.000	2.85	0.0044	40	46	0.0618
Right talocrural joint – sole flexion	1910.000	1831.000	1.78	0.0746	40	46	0.1428
Left hip joint – extension	1930.500	1810.500	1.67	0.0956	40	46	0.0992
Right hip joint – flexion	2095.000	1646.000	3.10	0.0020	40	46	0.0019
Left knee joint – flexion	1628.000	2113.000	–1.00	0.3186	40	46	0.3361
Right knee joint – extension	1526.000	2215.000	–1.94	0.0522	40	46	0.0643
Left talocrural joint– sole flexion	1618.000	2123.000	–1.36	0.1740	40	46	0.2944
Right talocrural joint – dorsal flexion	1896.000	1845.000	1.92	0.0553	40	46	0.1791
Left humeral joint – adduction	1840.500	1900.500	0.88	0.3800	40	46	0.3861
Right humeral joint – abduction	1499.000	2242.000	–2.14	0.0324	40	46	0.0369
Left hip joint – flexion	1942.000	1799.000	2.36	0.0181	40	46	0.0810
Right hip joint – extension	1992.000	1749.000	2.85	0.0044	40	46	0.0289
Left knee joint – extension	1915.500	1825.500	1.95	0.0511	40	46	0.1291
Right knee joint – flexion	1890.000	1851.000	1.62	0.1053	40	46	0.1966
Left talocrural joint – dorsal flexion	1970.000	1771.000	3.59	0.0003	40	46	0.0465
Right talocrural joint – sole flexion	1954.000	1787.000	2.28	0.0225	40	46	0.0643
Left hip joint – extension	2084.000	1657.000	3.41	0.0007	40	46	0.0026
Right hip joint – flexion	2081.000	1660.000	3.38	0.0007	40	46	0.0029
Left knee joint – flexion	1801.500	1939.500	0.61	0.5387	40	46	0.5962
Right knee joint – extension	1757.500	1983.500	0.18	0.8598	40	46	0.8802
Left talocrural joint – sole flexion	1880.000	1861.000	1.42	0.1561	40	46	0.2284
Right talocrural joint – dorsal flexion	1778.000	1963.000	0.57	0.5696	40	46	0.7467
Left hip joint – flexion	2026.000	1715.000	3.09	0.0020	40	46	0.0129
Right hip joint – extension	1961.000	1780.000	2.39	0.0170	40	46	0.0560
Left knee joint – extension	1980.000	1761.000	2.59	0.0096	40	46	0.0377
Right knee joint – flexion	1942.000	1799.000	2.18	0.0291	40	46	0.0810
Left talocrural joint – dorsal flexion	1882.000	1859.000	2.21	0.0270	40	46	0.2218
Right talocrural joint – sole flexion	1944.000	1797.000	2.16	0.0304	40	46	0.0780

statistically significant values at the level $p \leq 0.05$ are marked in bold type.

enabled me to work out a desired algorithm of movements. Knowing the succession of movement appearances, I established exactly a number of sequences occurring in each joint. Thus, the model backstroke technique consisted of 592 sequences. I repeated the same procedure for all the video records of the participants. Knowing the number of sequences in each joint in both experimental and control groups I was able to compare the performances in each of them. In order to do it I made use of the *U* Mann-Whitney's test [17] (Tab. 1).

In addition, the established number of the sequences made it possible to calculate the swimming accuracy coefficient worked out and empirically verified by Zatoń [9].

Swimming accuracy coefficient W_{op}

$$W_{op} = \frac{l_{pw}}{l_c} = \frac{l_c - l_o - l_p}{l_c}$$

where:

- W_{op} – is a swimming accuracy coefficient, which takes into consideration the number of sequences omitted and presented,
- l_{pw} – number of correctly occurred sequences in a given person,
- l_c – number of total sequences (in the pattern),
- l_o – number of omitted sequences,
- l_p – number of presented sequences.

Results

The analysis of the results shows that the difference in the values of swimming accuracy coefficient in the experimental and control group is statistically significant in favour of the experimental group. Due to this fact, the gestures eliminating errors in body positions in the water and the gesture indicating the place where the lower limbs should start their movement were essential. A bit less important, but still significant, were the differences in accuracy of single movements: abduction of the arm, flexion of the dorsal talocrural joint, extension of the knee joint.

Discussion

The analysis of the results obtained in the present experiment shows that pupils who took advantage of non-verbal communication means, i.e. the visual information prepared in the form of gestures, demonstrated a more accurate technique. Those who mainly took ad-

vantage of verbal information during swimming lessons demonstrated a less accurate technique of movements. Since the differences between the experimental and control groups were already visible just after only seven lessons, it can be presumed that the gap will increase in the further learning process. Thus, the pupils from the control group will perpetuate their incorrect movements in the successive repetitions, which will cause structural changes around synapses and, consequently, lead to remembering errors in the permanent memory.

Later elimination of undesired movements will require additional time and effort. Claude Shannon, presently considered the father of the classical information theory, in his theory about the communication of information stated that information could be transmitted in an optimal way through an interference channel [18]. Shannon claimed that disturbances slow down the transmission speed, but do not make the information less accurate. Moreover, he maintained that there is always a coding and decoding method, due to which the probability of error occurrence can become deliberately small. This experiment confirms that gestures can be an effective method of coding and decoding information, provided a previous agreement as to their meanings between the teacher and the learner.

In the 1970s, Pyżow [19–21] dealt with application of gestures during swimming lessons. Since then, there has been a gap in research on this issue. In spite of that, the issue of using gestures in order to eliminate incorrect movements while learning swimming seems to me worth discussing, because (as the results of the experiment show) information communicated in this way influences considerably accuracy of acquirement of the swimming technique.

In the present experiment gestures turned out to be more efficient than verbal communication, because the eye receives a larger quantity of information per second than the ear; moreover, for children images are clearer and help understand better the whole movement structure [8]. In addition, gestures reach the pupil even in difficult conditions (considering a general buzz at the swimming pool), so they are an efficient substitute of words.

Contemporary psychology tends to attribute more and more importance to the communication processes [22]. While a new motor activity is being taught, the movement course is directed by the information which becomes the key to its successful acquirement. These pieces of information have been called by Bogen [23] "basic supporting points". According to him directing concentration of consciousness to the most important elements increases teaching effectiveness and shortens

the time of acquiring a new motor task. Also, in this experiment the most important pieces of information were encoded in a series of gestures and became the stimuli to which the pupil reacted in a proper way, correcting errors in movements, and as a result, he/she could swim technically better.

Domaradzki [24] dealt with application of gestures during swimming lessons. He observed teachers while they were working and distinguished the following groups of gestures: teaching, correcting, reinforcing and organizing. On the basis of his research he drew a conclusion that experienced teachers used visual communication more than novice ones. Moreover, he noticed that the most commonly used gestures regarded organization of a lesson and correction of wrong movements. Unfortunately, Domaradzki did not examine an influence of gestures on accuracy of acquirement of the swimming technique.

Also, Dybińska [25] studied visual communication. In her experiment she used visual information in the form of programme cards. By means of them, visual information was communicated to pupils before a motor task started, during its execution and after the lesson when the teacher and pupils were discussing their mistakes. In Dybińska's experiment, the visual information contained on the programme cards was an efficient method of communicating information about movements. In this work, as well, visual communications (in this case – gestures) appeared to be an efficient way to communicate information about movements and how to correct errors when they occur.

In other works on the visual communication of information in teaching swimming activities Dybińska [26] stated that implementation of techniques of effective communication of visual information can have a considerable impact on effects in teaching motor activities, which has been confirmed by this experiment. Making use of gestures while teaching motor activities is especially important in the conditions when verbal communication appears inefficient. In such a case, gesture becomes the only source of information how to correct an error when it occurs.

Conclusions

Visual information, communicated by means of “the language of gestures”, has an influence on the accuracy of learning swimming motor activities.

1. In teaching swimming motor activities, visual information is more efficient than verbal information.

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